Addis Ababa Science and Technology University

College of Architectural and Civil Engineering

IMPACT OF VARIATION ORDERS ON PUBLIC BUILDING PROJECTS IN ADDIS ABABA, ETHIOPIA

Independent project Submitted to College of Architecture and Civil Engineering of Addis Ababa Science and Technology University in partial fulfillment of the requirements for the Degree of Master of Engineering in Civil Engineering

(Construction Technology and Management)

BY

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MAY, 2017

ACKNOWLEDGEMENTS

First of all I would like to thank the Almighty God, Who gave me the commitment and tolerance to pass various obstacles and come up to the accomplishment of this research.

Next I would like to acknowledge Ethiopian Roads Authority for giving me the chance of this master's program.

My special gratitude goes to all organizations and individuals who contributed directly or indirectly to this research and provided the necessary materials and support for realization of this research. Especial thanks are forwarded to contractors, consultants and clients (project owners) who sacrificed their time in filling the questionnaires.

Furthermore, I am grateful to my lovely families for their invaluable support and encouragement during the project work. Last but not least, I would like to thank my friend Genet Damitew for her courage and support in providing me with various types of journals in the field of study.

ACKNOWLEDGEMENTS i
LIST OF TABLES v
LIST OF FIGURES vi
LIST OF ABBREVIATIONS vii
ABSTRACT viii
CHAPTER ONE 1
INTRODUCTION 1
1.1 Background of the Study 1
1.2 Statement of the Problem 2
1.3 Aim and Objectives of the Study 2
1.4 Research questions 2
1.5 The Study Scope and Limitation 3
1.6 The Research Organization 3
CHAPTER TWO 4
LITERATURE REVIEW 4
2.1 Introduction 4
2.2 Definition of variations 4
2.3 Classification of Variation Orders 4
2.4 Nature of Variation Order 5
2.4.1 Beneficial variation orders 5
2.4.2 Detrimental variation orders 5
2.5 Origin and causes of variation orders 5
2.5.1 Introduction 5
2.5.2 Origin agents 6
2.5.2.1 Client 6
2.5.2.2 Consultant 7
2.5.2.3 Contractor 8
2.5.2.4 Situations beyond control of parties to the contract 9
2.5.3 Causes of variation orders 9
2.6 Contractual provisions relative to variation orders 13
2.6.1 Introduction 13

2.6.3 Conditions of Contract for Construction (MDB FIDIC, 2006) 16
2.7 Impacts variation orders 19
2.8 Management of variation orders 24
2.9 Chapter summary 25
CHAPTER THREE 28
RESEACH METHODOLOGY 28
3.1 Introduction 28
3.2 The Study Approach 28
3.3 Population and Sampling Techniques 29
3.4 Data Collection 30
3.5 Method of Analysis 30
CHAPTER FOUR 32
DATA ANALYSIS AND DISCUSSION 32
4.1. Introduction 32
4.2 Analysis of Data from the Case study 32
4.2.1 Project 1 33
4.2.2 Project 2 33
4.2.3 Project 3 34
4.2.4 Project 4 34
4.2.5 Project 5 34
4.2.6 Project 6 35
4.2.7 Findings from the Case Study 37
4.2.7.1 Causes of Variation Orders 37
4.2.7.2 Impact of Variation Orders 37
4.3 Analysis of Data from the Questionnaires 38
4.3.1 Questionnaire Response Rate 38
4.3.2 Respondents' Profile 38
4.3.3 Respondents' Experience 39
4.3.4 Findings from the Questionnaires 39
4.3.4.1 Cause of variation orders on public building projects 39
4.3.4.2 Impacts of variation orders on public building projects 42

4.3.4.3 Recommended Strategies to Minimize Variation Orders 43
4.4 Discussion of Findings 44
4.4.1 Causes of variation orders in public building projects 44
4.4.2 Impacts of variation orders 45
4.4.3 Recommended Strategies to Minimize Variation Orders 46
CHAPTER FIVE 48
CONCLUSION AND RECOMMENDATIONS 48
5.1 Conclusion 48
5.1.1 Causes of variation orders on public building projects in Addis Ababa 48
5.1.2 Impact of variation orders on public building projects in Addis Ababa 48
5.1.3 Recommended strategies to minimize variation orders 48
5.2 Recommendations 49
5.2.1 Expected From Clients/Project Owners 49
5.2.2 Expected from Consultants 49
5.2.3 Expected From Contractors 50
REFERENCES 50
APPENDEX 52

LIST OF TABLES

Table 2.1: Causes of variation orders

Table 2.2: Impacts of variation orders

Table 4.1: List of selected building projects

Table 4.2: Summary of causes and impact of variation orders data from the desk study

Table 4.3: Causes of variation orders from the case study

Table 4.4: Impacts of variation from the desk study

Table 4.5: Summary of questionnaires distributedand returned; and response rate

Table 4.6 Respondents' Experience

Table 4.7: Causes of variation orders

Table 4.8: Impacts of variation orders

Table 4.9: Recommended strategies to minimize variation orders

LIST OF FIGURES

Figure 2.1 Variation order process

Figure 3.1 Flow chart of research organization

LIST OF ABBREVIATIONS

CII Construction Industry Institute

FIDIC Federation International des Ingenieurs-Conseils: a French acronym interpreted in English as International Federation of Consulting Engineers

MUDCMinistry of Urban Development and Construction

PPAPublic Procurement Agency

DCPDesign changes initiated by engineer or consultant familiar with the process

DCO Design change originated by owner

DCI Design changes caused by improvement through design process

GCC General Condition of contracts

VO Variation Order

MS Mean Score

ABSTRACT

This study investigated the impact of variation orders on public building projects in Addis Ababa inorder to take proactive measure to reduce them. The study had the following objectives, namely (1) To identify the main causes of construction variation orders in public building construction projects in Addis Ababa;(2) To assess the impact of construction variation orders on public building construction projects in Addis Ababa; and (3)To forward recommendations to effectively control and manage construction variation orders. Literature relative to the research area was comprehensively reviewed. Questionnaire survey together with case study was used to collect data on variation orders.32 questionnaires from clients, consultants and contractors were collected and a case study on six(6) public building projects in Addis Ababa were investigated and analyzed using both descriptive and inferential statistics. A ranking system using the "Mean score (MS)"method was calculated to find the most significant factor for each section. From the results it was found that design change , additional work order by the client interest, change in specification, incomplete design at the time of tender, and differing site conditions were the major causes of variation orders. The results also showed that completion schedule delay, increase in project cost and delay in payment were the major impacts of variation orders. From the findings recommended strategies to minimize variation orders were complete the drawings at tender stage, all involved parties should plan adequately before works start on site and clients should provide a clear brief of the scope of works.

Key words: Variation order, cause, impact

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Ethiopia is one of the fastest growing countries in East Africa and construction has become an important player on the economy of the country.As compared to other parts of the country, the sector has invested huge capital investment in and around the capital city, Addis Ababa, for the construction of different civil engineering works such as building complexes, toll roads, rail road, water supply expansion structures, etc. Complex nature of construction projects make it hard to finish any of construction projects without changing in plans or in the construction process itself. The common practice of construction industry is project-based. Generally, construction project includes many stages from planning, architectural drawing, engineering designs, cost estimation, bidding, contracting to the actual implementation of the project. During these phases many decisions have to be made based on incomplete information, assumptions and personal experience of construction professionals. Whatever the scope of projects, the size of construction processes may vary significantly, they tend to have one common element which is "Variation ". Variation is very common and likely to occur at any stage of construction. Variation requests contain a set of instruction which allows modifications, additions or deletions to be made to the origin contract agreement in terms of volume and scope of work or nature of task to be carried out. Variation orders affect the progress of any construction project and may be one of the main factors that might cause failure in delivering a project successfully. Upon acknowledging its existence, the variation is formally regularized by the issuance of a variation order which is a document describing the scope of the variation and its impact on both cost and / or time. If no agreement is reached between the parties of the project on the variation, it turns into a claim or dispute that may negatively affect the execution of the project and curtail its chances of successful completion.

Most public building projects in Addis Ababa time delays and cost overrun increase as a result of variations to construction contracts .Therefore, it is necessary to identify and evaluate the impact of variation orders on public buildings projects in Addis Ababa.

1.2 Statement of the Problem

A variation order is a written order to the contractor, signed by the owner, and issued after signing of the contract, authorizing a variation in the work or an adjustment in the contract sum or the contract time. Variation in drawings and contract documents usually lead to change in contract price or contract schedule. Variation also increases the possibility of contractual disputes. In general, Variation present problems to all parties involved in the construction process. There are many reasons for issuing construction variation orders in large construction contracts. It might be a result of further development of the owner's requirements. It can be a result of non-availability, slow delivery of required materials or correction of contract document errors and omissions. Identifying the causes of variation orders is very important in order to avoid potential changes in future projects or minimize their effects.

1.3 Aim and Objectives of the Study

The aim of this research is to make assessment of the impact of construction variation orders on public building construction projects in Addis Ababain order to take proactive measures to reduce them.

To achieve the aim of this research many objectives exists, these objectives can be summarized as bellow:

- To identify the main causes of construction variation orders in public building construction projects in Addis Ababa.
- To assess the impact of construction variation orders on public building construction projects in Addis Ababa.
- To forward recommendations to effectively control and manage construction variation orders.

1.4 Research questions

The complexity of the construction industry due to different stakeholders' involvement makes it differ from other industry. This complexity gives rise mostly to unwanted situation like variations with their attached effects, and the more variation orders on a project, the greater the likelihood that they become time consuming and costly construction projects. It is almost becoming a rare thing for a construction project not to have variations due to various reasons.

Variation orders in Ethiopian construction sector may or may not have different sorts of impacts on project's performance from what is internationally identified.

Hence, in this research, the following questions thoroughly scrutinized and the focus of the research swivel around such questions as:

- What are the causes of variation ordersin public construction projects in Addis Ababa?
- What kind of impact do variation ordershave on public construction projects?
- How do variation orders can be minimized in the Ethiopian construction industry?

1.5 The Study Scope and Limitation

The study was limited to Addis Ababa city where a number of public building construction projects are under construction.Documents, records and variation orders analyzed include those public buildingconstruction projects which theircommencementstarting from April 2012 G.C due to un availability of the required data. Case studies conducted on projects where information regarding various aspects of variation orders observed.

1.6 The Research Organization

Chapter 1 presented the introductory part of the research which includes; Research background, Statement of the problem, Research objective, Research questions, The Study Scope and limitationand Research organization.

Chapter 2 This chapter explored previous studies related to variation orders. The origin causes and impact of variation orders on projects performance.

Chapter 3 Presented the research methodology

Chapter 4 Presented the data analysis and discussion on the result.

Chapter5 Presented the summary, conclusion and recommendation of the research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Variation is common in all types of construction projects and plays an important role in determining the closing cost and time of the projects. It is therefore important to understand the impact variation orders, but it is also important to understand the causes of variation orders. Before variation orders can be properly handled, it is imperative to the parties involved in the construction to be aware of the variation orders and the reason behind such orders that could possibly be encountered during the process of executing the project. Therefore, this research shall focus on identifying the leading causes of variation orders in public building construction projects in Addis Ababa and assessing their impact. There have been numerous literatures written on variation, variation orders and its cause and management in construction. Most of the articles written discuss the legal aspects of variations such as claims and disputes. Many other articles were devoted to the discussion of the effects of variation orders. Although this review is by no means a comprehensive one, it covers the most important articles and subjects and can open the door for further research on the subject of variation orders.

2.2 Definition of variations

Variation order is the deviation experienced in any project from base contract or work scope mutually agreed at contracting time (Keane et al., 2010). It is written agreement between the contracting parties that represent an addition, deletion, or revision to the contract documents, identifies the change in price and time and describes the nature of the work involved (CMAA, 1993). Variation orders arise for a variety of causes, of which some causes are foreseeable and others are not. Many researchers have identified various causes of variation orders (CII, 1990a; Thomas and Napolitan, 1995; Clough and Sears, 1994; Fisk, 1997; Ibbs et al., 1998; O'Brien, 1998; Mokhtar et al., 2000;Gray and Hughes, 2001; Arain et al., 2004).

2.3 Classification of Variation Orders

Variation orders can be classified in many different ways depending on the basis and the purpose of classifications. In this review, the most common classifications are presented.Changes in a

construction project can be classified based on the cause that forced them. Burati et al. (1992) stated that changes in constructions are caused by design, construction, fabrication, transportation or operability. Design changes, were found to constitute 52.5% of total changes, fall mainly into three categories:

- Design changes caused by improvement through design process (DCI). Examples are changes resulting from design reviews, technological advances or constructability reviews.
- Design changes originated by Owner (DCO). Examples are scope changes.
- Design changes initiated by Engineer or Consultant familiar with the process (DCP).Examples are additions of pumps, valve or instrumentation that affect the operation of the facility.

2.4 Nature of Variation Order

The nature of a variation order can be determined by referring to both the reasons for their occurrence and subsequent effects. Arain and Pheng (2005) distinguished two types of variation orders namely: beneficial and detrimental variation order.

2.4.1 Beneficial variation orders

A beneficial variation order is one issued to improve the quality standard, reduce cost, schedule, or degree of difficulty in a project. A beneficial variation order eliminates unnecessary costs from a project as a result; it optimizes the client's benefits against the resource input by eliminating unnecessary costs.

2.4.2 Detrimental variation orders

A detrimental variation order is one that negatively impacts the client's value or project performance (Arain and Pheng, (2005). For example a client who is experiencing financial problems may require the substitution of quality standard expensive materials to substandard cheap materials.

2.5 Origin and causes of variation orders

2.5.1 Introduction

While variation orders are common in construction projects, an improved understanding would require their categorization into their root or origin agents and causes. The cognizance of origin

agent consists of the identification of the initiator of the variation orders. A study that focused on the point of view of developers of potential causes of variation orders suggested four main origin agents of variation orders (Arain&Pheng, 2006). These included "client", "consultant", "contractors "and "others". There is an interrelation between the origin agent and causes of variation orders.

2.5.2 Origin agents

2.5.2.1 Client

The client as the project initiator plays a major role in the construction projectfrom the inception to the completion phases. As a result, clients influence the likelihood of the occurrence of variation orders. Clients anticipate the needs and objectives of projects, establish the scope of works and the required quality standards. During the construction stage, clients initiate variation orders due to various reasons.Uyun (2007) remarked that the principal reason for the client to initiate variation orders is a change in requirements, for example, rethinking of the needs or change of the use of the anticipated future utilization of finished works. Clients are mainly classified under two categories: Clients who have the knowledge and experience of the construction industry and those without or with little experience. Clients with experience in construction are involved during the design stage by providing professional guidance to the design team. This participation may contribute to the avoidance of continuous changes during the construction stage. For example, public entity clients and private development companies have their own professional team responsible either for design or supervision of a commissioned designer. The technical input into the design by clients prevents them from fully relying on the designer, minimizing the chance of them changing their mind during the construction stage. Clients without or with little knowledge in construction tend to follow the guidance of the designer without any clear idea that their requirements have been met. Uyun (2007) remarked that it is sometimes very difficult to determine the exact requirements of the client. If the objectives of the project are inadequately defined, it is common that clients will tend to change their minds along the way. Clients struck with unexpected financial difficulties during the construction stage initiate changes in order to suite their conditions. Changes may include replacement of materials, changeof design, scope and schedule of works. As a result, such changes lead to qualitystandard degradation and high maintenance cost.

2.5.2.2 Consultant

Traditionally, clients have been relying on the expertise of the architect whose responsibility would be to carry out the design and supervise the works on site.Nowadays, the complexity of modern projects, the emergence of new technologies and financial accountability demand a wide range of expertise from consultant team rather than a single body representing the client. The consultant team includes architects, designers, specialist engineers, project managers and cost consultants. Members of the consultant team have power to effect variation orders upon delegation by the client or on their behalf.In case errors, omissions or discrepancies are found in the design or a conflict is discovered between the contract documents, it is the duty of the consultant to provide a remedial solution. A contractor who finds a problem to interpret ambiguous design details and inadequate working drawings notifies the concerned consultant as soon as possible. A contractor cannot proceed with work where ambiguous situations arise. A delay by a consultant in issuing a variation order may result in losses in terms of idle labor and plant while waiting for the consultant's decision. Acharya*et al.* (2006)suggested that consultants should aim at getting an understanding of the overall scope and goals of the project, make sure they understand deliverables and offer specific suggestions when it makes sense. All has to be done relatively quickly without having any negative effect on productivity. Unfortunately, the feeling of superiority of the consultant over the contractor may hinder the consultant from giving attention to requests by the contractor. Acharya*et al.* (2006) accused consultants of protecting their own interest at the expense of the interest of the client and the contractor. Basically, the role of the consultant is to advise the client on technical, legal and financial matters. Where deemed necessary, it is common for the consultant to issue a variation order for improvement purposes. During the briefing stage, clients state their requirements and these constitute the basis for formulating contract documents. Unfortunately, a failure by the consultant to interpret the requirements results in the design being different from the perceived one. As a consequence, variation orders will be issued to ensure compliance with the requirements for the client.Technology change may influence a consultant to initiate variation orders. Zimmerman and Hart (1982) indicated that it is impossible to be knowledgeable of all new materials and products that are constantly entering the market. The designer may be unaware of affordable alternative materials for finishes. This can lead to variation orders when full information about the materials is available. However, Acharya*et al.*(2006) insisted that when a new technology is

applied, at the same time, it must be seen whether skilled people are available to convert the technology into the real work. Otherwise, improper application of the technology may lead to quality degradation or monetary losses.Focusing more effort during the design phase would contribute greatly to the reduction of the occurrence of variation orders during the construction phase. Arainand Pheng (2005b) suggested the following:

- The involvement of the consultants in the design phase would assist inclarifying the project objectives and in identifying the non-compliance with their requirements at early stage. Eventually, this may help in eliminating theOccurrence of variation orders arising from errors and design discrepanciesduring the construction stage where the impact of variation orders can besevere.
- The continuous coordination and direct communication would not onlyeliminate design discrepancies and errors as well omissions in the design, butalso provide an opportunity for professionals to review the contract documentsthoroughly that would help in eliminating the variation orders arising because of conflicts in contract documents.
- The control of the frequent changes in design by consultant, and inadequateworking drawing details would be through thorough detailing of the design. This process will provide an opportunity for the consultant to review and finalize the design during the design phase. This would assist in reducing thevariation occurrences during the construction phases where the impact ofvariation order can be severe.

2.5.2.3 Contractor

It is common for a contractor to be the origin agent of variation orders. Sweeney (1998) advised that on every project, participants should keep an eye on problems. All parties to the contract have to be aware that the information provided by the consultant is not always accurate. It is the contractor's responsibility to advise the consultant to issue a variation order when a technical problem is discovered. Levy(2002) indicated that general contractors or their subcontractors may discover anobvious discrepancy, omission, error, or conflict in the contract document and request that the architect reviews thatproblem, discuss the additional costs to correct the situation, agree on a price, and authorize the variation order. A contractor may propose alternative construction methods where his experience shows that the proposed technology will not fulfill the desired fitness and function of a design. A wrong assumption by the designer for a technical school building in Nepal resulted in roof leakage (Acharya*et al.,* 2006). The problemwould have been

avoided if the contractor had been experienced and was aware of possible adverse situations. Variation orders initiated following the default of the contractor are frowned upon by the client. Situations that give rise to default include defective workmanship, unfamiliarity with local conditions, poor management and lack of efficient communication. As a consequence, the contractor may not only suffer monetary loss but also damage to the reputation of the firm.

2.5.2.4 Situations beyond control of parties to the contract

Situations beyond the control of the contractual parties that give rise to variation orders include weather conditions, certain health and safety considerations, change in government regulations, change in economic conditions, socio-cultural factors and unforeseen problems (Arain&Pheng, 2006).

2.5.3 **Causes of variation orders**

Change of schedule: A change of schedule during the project construction phase may result in major reallocation of resources. A change in schedule means that the contractor will either be required to provide additional resources or keep some resources idle. In both cases, additional cost is incurred (Fisk, 1997;O'Brien, 1998).

Change in scope: Change of plan or scope of the project is one of the most significant causes of variation in construction projects (CII, 1990b). It is usually the result of inadequate planning at the project definition stage or because of lack of involvement of the owner inthe design phase (Arain*et al*., 2004).

Owner's financial problems: The owner's financial problems can affect project progress (Clough and Sears,1994; O'Brien, 1998). This problem often leads to change in work schedules and specifications, affecting the quality of the construction.

Impediment to prompt decision-making process:

Prompt decision making is an important factor for project success (Sanvido*et al*., 1992; Gray and Hughes,2001). Failure to make the decision efficiently may result in the delay, causing the need for the change order due to cost increments.

Obstinate nature of the owner: A building project is the result of the combined efforts of the professionals involved, which have to work at the various interfaces of a project (Wang, 2000; Arain*et al*., 2004). If the owner is obstinate then this could cause major variations at the later stages of a project.

Change in specifications by the owner: Changes in specification is a common phenomenon in construction projects with inadequate project objectives (O'Brien,1998). If these changes in the specification of the design or requirement are carried out, this leads to variations in the construction phase.

Change in design by the consultant: A change in design improvement by the consultant is a norm in contemporary professional practice (Arain*et al*., 2004).Changes in design were frequent in projects where construction starts before the design is finalized (Fisk,1997). Such changes affect the project in various ways depending on the timing of the change.

Conflicts among contract documents: Conflict between contract documents can result in misinterpretation of the actual requirement of a project(CII, 1986). It is essential that the contract documents are clear and precise. Insufficient details in the contract documents may result in delays to the project completion or cause variations in cost.

Design complexity: Complex designs require unique skills and construction methods (Arain*et al*., 2004).

Complexity affects the flow of construction activities, whereas simpler and linear construction works are relatively easy to handle (Fisk, 1997).

Inadequate working drawing details: To convey a complete concept of the project design, the working drawings must be clear and concise (Geok, 2002).Inadequate working drawing details can result in misinterpretation of the actual requirements for the project (Arain*et al*., 2004), causing variations in the project.

Change in specification by the consultant: Changes in specification are observed frequently in constructionprojects (O'Brien, 1998). Changes in specification results in variations to the project, leading to delay and increased overall cost.

Unavailability of equipment: Unavailability of equipment is a procurement problem that can affect theproject completion (O'Brien, 1998).

Shortage of skilled manpower: Skilled manpower is one of the major resources required for technological projects (Arain*et al*., 2004). Variations and delays may occur due to shortages of skilled labor.

Contractor's financial difficulties: Construction is a labor intensive industry. Whether the contractor has been paid or not, the wages of the worker must still be paid (Thomas and Napolitan, 1995). If a contractor experiences financial difficulties during the course of a project,

it may result in lacking of resource availability.Consequently, the progress of the project is affected which may require variation and extension of time.

Poor workmanship: Defective workmanship may lead to demolition and rework in construction projects (Fisk, 1997; O'Brien, 1998). This results in delay andincreased cost.

Poor procurement process: Procurement delays have various adverse effects on other processes in the construction cycle (Fisk, 1997). Other processes in the construction cycle are affected by poor procurement processes. Consequently, variations are required.

Lack of strategic planning: Proper strategic planning is an important factor for successful completion of a building project (Clough and Sears, 1994). The lack of strategic planning is a common cause of variations in projects where construction starts before the design is finalized (e.g., in concurrent design and construction contracts) (O'Brien, 1998).

Inadequate design: Inadequate design can be a frequent cause of variations in construction projects (CII, 1990a; Fisk, 1997).

Various causes of variation orders reviewed from different literatures shown on Table 2.1

Table 2.1: Causes of variation orders

S.N	Causes of variation orders
1	Change of plans or scope
2	Change of schedule
3	Change in specifications
4	Change in design
5	Errors and omissions in design
6	Incomplete design at the time of tender
7	Non-compliant design with government regulations
8	Impediment in prompt decision making process
9	Unforeseen problems
10	Replacement of materials or procedures
11	Inadequate shop drawing details
12	Lack of judgment and experience
13	Financial problems
14	Inadequate scope of work for one or more parties to the contract

15	Design complexity
16	Lack of communication
17	Defective workmanship
18	Design discrepancies
19	Inadequate project objectives
20	Long lead procurement
21	Lack of coordination
22	Ambiguous design details
23	Unavailability of skills
24	Weather conditions
25	Lack of strategic planning
26	Lack of knowledge of available materials and equipment
27	Lack of involvement in design of one or more parties to the contract
28	Non-compliant design with owner's requirement
29	Health and safety considerations
30	Lack of a specialized construction management
31	Obstinate nature of one or more of the parties to the contract
32	Differing site conditions
33	Poor procurement process
34	Conflicts between contract documents
35	Lack of required data
36	Unavailability of equipment
37	Unfamiliarity with or unawareness of local conditions
38	Socio-cultural factors
39	Change in government regulations
40	Technology change
41	Insufficient time for preparation of contract documents
42	Improper briefing by client
43	Inadequate design team experience
44	Owner instructs modification to

	Design
45	Under estimation of initial quantity in the contract document

2.6 Contractual provisions relative to variation orders

2.6.1 Introduction

As has been previously stated, a variation order is any modification to the contractual terms of a project by the client or the client's representative (Arain&Pheng, 2005b). It is a formal decision to alter a previous decision which affects the work or objectives of the other teams (Bennett, 1985). In practice, variation orders are issued in the form of site instructions typically issued by architects. Uff (2005) argued that disputes often arise as to whether an instruction constitutes a variation order because the contract does not contain a definition of what may constitute a variation. Ssegawa*et al*. (2002) contend that there is no single definition of what a variation is. Not all architect's instructions constitute variation orders such as for example, an instruction to remove defective work (Wainwright & Wood, 1983;FIDIC, 1999). The JBCC (2005) defined a contract instruction as a written instruction signed and issued by or under the authority of the principal agent to the contractor. The FIDIC (1999) general conditions clause 3.3 stipulates that the engineer may issue to the contractor instructions and additional or modified drawings which may be necessary for the execution of the works and the remedying of any defects, all in accordance with the contract. But, not all instructions vary the contractual arrangements or the way the works are being undertaken. Consequently, some contract instructions may be considered as variation orders while others are not.

2.6.2 General Conditions of Contract for Procurement of Works (PPA, 2011)

According to General Conditions of Contract for Procurement of Works (PPA, 2011)conditions of contracts for construction of civil works project, variation related clauses are read as follows:

- **Modifications by Change Orders**

Clause 15.1: The Engineer shall have power to order any modification to any part of the works necessary for the proper completion and /or functioning of the works. Such modifications may include additions, omissions, substitutions, changes in quality, quantity, form, character, kind, position, dimension, level or line and changes in the specified sequence, method or timing of execution of the works. No order for a modification shall have the effect of invalidating the

contract, but the financial effect, if any, of all such modifications shall be valued in accordance with GCC Clauses 15.5 and 15.7.

Clause 15.2 : All change orders shall be issued in writing, it being understood that:

(a) if for any reason, the Engineer shall find it necessary to give an order orally, he shall as soon as possible thereafter confirm the order by any change order;

(b) if the Contractor shall confirm in writing an oral order given for the purpose of GCC Clause 15.2 (a) and the confirmation shall not be contradicted in writing forthwith by the Engineer, any change order shall be deemed to have been issued for the modification. A change order for modification shall not be required for increase or decrease in the quantity of any work where such increase or decrease is the result of the quantity exceeding or being less than that stated in the bill of quantities or price schedule, as the result of valuation of works laid down in GCC Clause 63.

Clause 15.3: Except as provided by GCC Clause 15.2 prior to any change order for modification, the Engineer shall notify the Contractor of the nature and form of such modification. As soon as possible, after receiving such notice, the Contractor shall submit to the Engineer a proposal containing:

a description of the tasks, if any, to be implemented or the measures to be taken and a program for execution; andany necessary modifications to the program of implementation of tasks or to any of the Contractor's obligations under the contract; and

(c) any adjustment to the contract price in accordance with the rules as set out in this Clause.

Clause 15.4: Following the receipt of the Contractor's submission referred to in GCC Clause 15.3, the Engineer shall, after due consultation with the Public Body and, where appropriate, the Contractor, decide as soon as possible whether or not the modification shall be carried out. If the Engineer decides that the modification shall be carried out he shall issue the change order stating that the modification shall be carried out at the prices and under the conditions given in the Contractor's submission referred to in GCC Clause 15.3 or as modified by the Engineer in accordance with GCC Clause 15.5.

Clause 15.5: The prices for all modifications ordered by the Engineer in accordance with GCC Clause 15.2 and 15.4 shall be ascertained by the Engineer in accordance with the following principles:

where work is of similar character and executed under similar conditions to work priced in the

bill of quantities or price schedule it shall be valued at such rates and prices contained therein; where work is not of a similar character or is not executed under similar conditions, the rates and prices in the contract to be agreed through negotiation between the Engineer and the Contractor shall conform to the prevailing market price;

(c)if the nature or amount of any modification relative to the nature or amount of the whole of the contract or to any part thereof shall be such that in the opinion of the Engineer any rate or price contained in the contract for any item of work is by reason of such modification rendered unreasonable, then the Engineer shall fix such rate or price as in the circumstances he shall think reasonable and proper;

Where a modification is necessitated by default or breach of contract by the Contractor, any additional cost attributable to such modification shall be borne by the Contractor.

Clause 15.6: On receipt of the change order requesting the modification, the Contractor shall proceed to carry out the modification and be bound by these GCC in so doing as if such modification were stated in the contract. The works shall not be delayed pending the granting of any extension of time for completion or adjustment to the contract price. Where the order for a modification precedes the adjustment to the contract price, the Contractor shall keep records of the costs of undertaking the modification and of time expended thereon. Such records shall be open to inspection by the Engineer at all reasonable times.

Clause 15.7: Where on provisional acceptance an increase or reduction in the total value of the works resulting from a change order, or from some other circumstance which is not caused by the Contractor's default, exceeds 25% of the initial contract price (or as modified by addendum), the Engineer shall, after consultation with the Public Body and the Contractor determine any reduction from the contract price as a consequence of the application of GCC Clause 15.5. The sum so determined shall be based on the amount by which the increase or decrease in value of the works exceeds 25%. The sum shall be notified by the Engineer to the Public Body and the Contractor and the contract price adjusted accordingly.

Clause 15.8: The total value of the works resulting from a change order shall not exceed 30% of the total value of the initial contract price.

Clause 15.9: Any change to the terms of the Contract must be recorded in writing and executed by authorized signatory of the Contractor and the Engineer. Such record of the change in question must address all consequential amendments required to be made to the Contract as a

result of such change.

Clause 15.10: Changes will take effect as from the date specified in the signed record of change and shall not have retrospective effect unless expressly provided for in such record.

Clause 15.11: Each record of change must be dated and sequentially numbered. Each of the Public Body and the Contractor will be entitled to an original executed counterpart of the record of variation.

Clause 15.12: Except as provided in any such record of variation, the Contract will continue in full force and effect.

Clause 63.1 (a) iii): The Engineer shall determine by measurement the actual quantities of the works executed by the Contractor, and these shall be paid for in accordance with GCC Clause 64. Unless otherwise provided in the SCC no additions shall be made to the items in the bill of quantities except as a result of a modification in accordance with GCC Clause 15 or another provision of the Contract entitling the Contractor to additional payment

2.6.3 Conditions of Contract for Construction (MDB FIDIC, 2006)

According to conditions of Contract for Construction (MDB FIDIC, 2006)conditions of contracts for construction of civil works project, variation related clauses are read as follows:

- **Instructions of the Engineer**

Clause 3.3: The Engineer may issue to the Contractor (at any time) instructions and additional or modified Drawings which may be necessary for the execution of the Works and the remedying of any defects, all in accordance with the Contract. The Contractor shall only take instructions from the Engineer, or from an assistant to whom the appropriate authority has been delegated under this Clause. If an instruction constitutes a Variation, Clause 13 [Variations and Adjustments] shall apply.

The Contractor shall comply with the instructions given by the Engineer or delegated assistant, on any matter related to the Contract. Whenever practicable, their instructions shall be given in writing. If the Engineer or a delegated assistant:

(a) gives an oral instruction,

(b) receives a written confirmation of the instruction, from (or on behalf of) the

Contractor, within two working days after giving the instruction, and

(c) does not reply by issuing a written rejection and/or instruction within two

working days after receiving the confirmation,

then the confirmation shall constitute the written instruction of the Engineer or delegated assistant (as the case may be).

- **Variation and Adjustments**

Clause 13.1:Variations may be initiated by the Engineer at any time prior to issuing the Taking-Overcertificate for the Works, either by an instruction or by a request for the contractor tosubmit a proposal.

The Contractor shall execute and be bound by each Variation, unless the Contractor promptly gives notice to the Engineer stating (with supporting particulars) that (i) the contractor cannot readily obtain the Goods required for the Variation, or (ii) such variation triggers a substantial change in the sequence or progress of the Works. Upon receiving this notice, the Engineer shall cancel, confirm or vary the instruction. Each Variation may include:

(a) changes to the quantities of any item of work included in the Contract (however,such changes do not necessarily constitute a Variation),

(b) changes to the quality and other characteristics of any item of work,

(c) changes to the levels, positions and/or dimensions of any part of the Works,

(d) omission of any work unless it is to be carried out by others,

(e) any additional work, Plant, Materials or services necessary for the Permanent works, including any associated Tests on Completion, boreholes and othertesting and exploratory work, or

(f) Changes to the sequence or timing of the execution of the Works.

The Contractor shall not make any alteration and/or modification of the Permanent Works, unless and until the Engineer instructs or approves a Variation.

Clause 13.2:The Contractor may, at any time, submit to the Engineer a written proposal which (in the Contractor's opinion) will, if adopted, (i) accelerate completion, (ii) reduce the costto the Employer of executing, maintaining or operating the Works, (iii) improve the efficiency or value to the Employer of the completed Works, or (iv) otherwise be of benefit to the Employer.The proposal shall be prepared at the cost of the Contractor and shall include the items listed in Sub-Clause 13.3 [*Variation Procedure*].If a proposal, which is approved by the Engineer, includes a change in the design of part of the Permanent Works, then unless otherwise agreed by both Parties:

(a) the Contractor shall design this part,

(b) sub-paragraphs (a) to (d) of Sub-Clause 4.1 [*Contractor's General Obligations*] shall apply, and

(c) if this change results in a reduction in the contract value of this part, the

Engineer shall proceed in accordance with Sub-Clause 3.5 [*Determinations*] to

agree or determine a fee, which shall be included in the Contract Price. This fee shall be half (50%) of the difference between the following amounts:

(i) such reduction in contract value, resulting from the change, excluding

adjustments under Sub-Clause 13.7 [*Adjustments for Changes in Legislation*] and Sub-Clause 13.8 [*Adjustments for Changes in Cost*], and

(ii) the reduction (if any) in the value to the Employer of the varied works,

taking account of any reductions in quality, anticipated life or operationalefficiencies. However, if amount (i) is less than amount (ii), there shall not be a fee.

Clause 13.3: If the Engineer requests a proposal, prior to instructing a Variation, the Contractor shall respond in writing as soon as practicable, either by giving reasons why he cannot comply (if this is the case) or by submitting:

(a) a description of the proposed work to be performed and a program for its execution,

(b) the Contractor's proposal for any necessary modifications to the program

according to Sub-Clause 8.3 [*Program*] and to the Time for Completion, and

(c) The Contractor's proposal for evaluation of the Variation. The Engineer shall, as soon as practicable after receiving such proposal (under Sub- Clause 13.2 [*Value Engineering*] or otherwise), respond with approval, disapproval or comments. The Contractor shall not delay any work whilst awaiting a response. Each instruction to execute a Variation, with any requirements for the recording of costs, shall be issued by the Engineer to the Contractor, who shall acknowledge receipt.Each Variation shall be evaluated in accordance with Clause 12 [*Measurement and Evaluation]*, unless the Engineer instructs or approves otherwise in accordance withthis Clause.

2.6.4 Standard Condition of Contract for Civil Works Project (MUDC, 1994)

According to Ministry of Urban Development and Construction (MUDC, 1994) conditions of contracts for construction of civil works project, variation related clauses are read as follows:

Clause 51, Variations: The engineer shall make any variation of the form, quality or quantity of

the works or any part thereof that may, in his opinion, be necessary and for that purpose, or if for any other reason it shall, in his opinion be desirable, he shall have power to order the contractor to do and the contractor shall do any of the following:

(a) Increase or decrease the quantity of any work included in the contract,

(b) Omit any such work,

(c) Change the character or quality or kind of any such work,

(d) Change the levels, lines, position and dimensions of any part of the works, and

(e) Execute additional work of any kind necessary for the completion of the works

and no such variation shall in any way vitiate or invalidate the contract, but the value, if any, of all such variations shall be taken into account in ascertaining the amount of the counteract price. Clause 52, Valuation of variations: All extra or additional work done or work omitted by order of the engineer shall be valued at the rates and prices set out in the contract if, in the opinion of the engineer, the same shall be applicable. If the contract does not contain any rates or prices applicable to the extra or additional work then suitable rates or prices shall be agreed upon between the engineer and the contractor. In the event of disagreement the engineer shall fix such rates or prices as shall, in his opinion, are reasonable and proper.

2.7 Impacts variation orders

Research on the impacts of variation orders were done by many researchers (Clough and Sears, 1994; Thomas and Napolitan, 1995; Fisk, 1997; Ibbs, 1997; Veenendaal, 1998; Reichard and Norwood, 2001; Arain and Low, 2005; Moselhi*et al.*, 2005). Changes that occur during construction will affect any project (Reichard and Norwood, 2001). Lewis (1991) indicated that change orders have its ripple impacts as a contractor does not work in a vacuum; rather must properly allocate his limited resources within projects and between actual and potential projects. Thus, whenever a change occurs, a contractor must make adjustments to work under the contract and reallocate time, material and labor resources. Arain and Low (2005), identified 16 impactsof variation orders on institutional building from the research they did in Singapore. The impacts that were determined are discussed further below.

Progress is affected but without any delay:-Project progress and quality may be affected by variations (Assaf*et al.,* 1995). During construction, time is of the essence. However, according to Arain and Low (2005), only major variations during the project may affect the project

completion time because the contractor would usually try to accommodate the variations by utilizing the free floats in the construction schedules. Therefore, variations will affect the project progress but without any delay in the project completion date.

Increases in project cost:-During the construction phase, the most common impact of variations is the increase in project cost (CII, 1990). The increase in the project cost is caused by any major additions or modifications to the design (Clough and Sears, 1994; Assaf*et al.*, 1995). Therefore, contingency sum will usually be allocated in every construction project to cater for any possible variations in the project, while keeping the overall project cost intact.

Hiring new professionals:-CII (1995), variations often occur in complex technologies projects, this may be caused by something was overlooked by the architect/engineer during the design stage. Complex technologies projects need specialists to get the job done (Fisk, 1997). Depending on the nature, occasionally, new professional need to be hired or the entire project team is replaced to execute the variations (Arain and Low, 2005). Hiring the new professionals takes time and thus affecting the project progress.

Increases in overhead expense :-Variations need to go through a few stages of processing procedures as mentioned earlier and require to be evaluated before they can even be implemented (O'Brien, 1998). Because of this, the overhead expense for all the parties involved will increase as there is a lot of work and paperwork need to be done. However, normally these overhead charges are provided for from the contingency fund allocated for the construction projects (Arain and Low, 2005).

Delays in payment:-Delay in payment occurred frequently due to variations in construction project (CII, 1990). CII (1995), variations may hinder the project progress as mentioned before thus leading to delays in the construction works done which will eventually affecting payments to the contractors. If the main contractor does not have enough funds to pay the subcontractors then this may cause severe problem to both the main contractor and the subcontractor as well. This can happen because some main contractor depends on the payment from client to pay the subcontractors.

Quality degradation:-Frequent variations may affect the quality of work adversely (Fisk, 1997). This maybe because of frequent variations may cause the contractors to compensate their losses by cutting corners.

Productivity degradation:-Variation orders often associated with interruption, delays and

modification of work do have a negative impact on labor productivity. Hester *et al.,* (1991), feels that the productivity of workers was expected to be seriously affected in cases where they were required to work overtime for prolonged periods to compensate for schedule delays. Thomas and Napolitan (1995), concluded from their research that variations normally led to disruptions and these disruptions' were reasonable for labor productivity degradation and on average, there is a 30 percent loss of efficiency when changes are being performed. Thomas and Napolitan (1995), also feel that the most significant types of disruptions were due to the shortage of materials and lack of information as well as the work out of sequence and these disruptions result in daily loss of efficiency in the range of 25 to 50 percent. Reichard and Norwood (2001), found out from their research that if variations reach 10 to 15 percent of the originally planned labor hours, productivity of the remaining unchanged work will decreased due to the extra labor hours spent on executing the variations. According to Moselhi*et al.,* (2005), the few factors that were found to influence the impact of variation orders on labor productivity are as follows:

i. Variation orders' intensity (numbers and frequency)

ii. Variation orders' timing (during which phase of the project)

iii. Variation orders' work type (architectural, civil, electrical or mechanical)

iv. Type of impact

v. On-site management

Procurement delay:-Revised procurement request may be required when variations occur during the construction phase of the project (O'Brien, 1998). Arain and Low (2005), feels that variations that require new materials and specialized equipment are the cause for frequent procurement delays. Procurement delays were common effects of variations related to new resources for construction projects (Hester *et al.,* 1991).

Rework and demolition:-Rework and demolition are common and frequent due to variations in construction projects (Clough and Sears, 1994). The main effects when variations occur during the construction phase are rework and delays in project completion. Time and resources are wasted when rework and demolition occurs. However, it do depends on the timing of the variations as if variations occur during the design phase, no rework or demolition is required on construction sites as things are not constructed yet (Arain and Low, 2005)

Logistics delays:-Most of the researchers (Hester *et al.,* 1991; Fisk, 1997; Arain and Low,

2005) believe that variations that require new materials and equipment may result in logistics delay in construction projects. This happen because time is needed for the ordering/booking and transportation of the materials and equipments on site.

Damage to firm's reputation:-Fisk, (1997) and Kumaraswamy*et al.,* (1998) felt variations are referred to as a major source of construction claims and disputes among the parties involved. The firm's reputation may be affected adversely by the claims and disputes which can lead to insolvency if the case is severe. The possibility of professional disputes also increases if variations occur. It is unquestionable that variations present many problems to all the parties which are involved in the construction project (Arain and Low, 2005).

Poor safety conditions:-The safety conditions in construction projects may be affected by variations (O'Brien, 1998; Arain*et al.,* 2004). Arain and Low (2005), this may be caused by the additional safety measures that may be required during construction because of variations.

Poor professional relations:-As mentioned before, construction changes are a major source of construction dispute (Fisk, 1997). Eventually, variations may affect professional relations, leading to disputes.

Disputes among professionals:-As discussed above, major construction changes usually leads to disputes. Therefore, clear procedures must be presented in the contract and fair allocation of risks among parties involved can help in resolving disputes through negotiation rather than litigation (CII, 1986; Arain*et al.,* 2004). Hanna (2007) suggested some strategies that both the client/developer and the contractor can undertake whenever there are variations which have cumulative impacts to the project to reduce disputes.

Additional payments for contractor:-Arain and Low (2005), observed that one of the most common potential effects of variations in construction projects is additional payments for the contractor. This is because variations are normally considered to be a common source of additional works for the contractor (O'Brien, 1998). Due to additional payments, the contractor looks forward to variations in the construction project. Some contractors even look for ways and excuses to initiate variations during construction just to obtain additional payments and increase their profit.

Completion schedule delay:-Completion schedule delay is a frequent result of variations in construction projects (Ibbs, 1997b). The magnitude of the schedule being delayed due to variations was reported to be 9 percent of the original schedule for 71 fixed price projects

studied (Zeitoun and Oberlender, 1993). Kumaraswamy*et al.,* (1998), studied claims for extension of time dye to excusable delays in Hong Kong's civil engineering projects. Their findings suggested that half of the projects surveyed were delayed because of variations. Delays in projects occur mainly because not only time is needed in evaluating and imposing variations but also due to the fact that variations have cumulative impacts on construction projects as reported by Reichard and Norwood (2001). All the potential effects of variations are also correlated, resulting in the completion schedule delays in construction projects. Impacts of variation orders reviewed from different literatures shown on Table 2.2

Table 2.2: Impacts of variation orders

S.N	**Impacts of variation orders**
1	Increase in project cost
2	Progress is affected but without any delay
3	Increase in overhead expenses
4	Delay in payment
5	Quality degradation
6	Productivity degradation
7	Procurement delay
8	Rework and demolition
9	Logistics delays
10	Additional specialist equipment/personnel
11	Poor safety conditions
12	Poor professional relations
13	Additional payments for contractor
14	Disputes among professionals
15	Completion schedule delay
16	Complaints of one or more of the parties to the contact
17	Professional reputation of one or more parties adversely affected
18	Damage to firm's reputation

2.8 Management of variation orders

As previously indicated variation orders are typically issued in the form of contract instructions. According to Ssegawa*et al.* (2002) contractual clauses state how variation orders should be initiated. In all cases, variation orders are issued by the consultant and must be given in writing or oral instruction should be subsequently confirmed in writing (Wainwright & Wood, 1983; FIDIC, 1999; Finsen, 2005; JBCC, 2005; Ssegawa*et al.,* 2002). "Writing" includes drawings, faxes, e-mails, telegrams and magnetic tapes and computer disks in which words and drawings may have been electronically recorded and are capable of being converted to text and drawings on paper or other similar media (Finsen, 2005). Since the contractor is not bound to comply with the oral instructions, all oral instructions have to be confirmed in writing by either the consultant or the contractor. Where variation orders are confirmed in writing by the contractor, the consultant has to confirm by signature. If the contractor is agreeable with the variation order, the works should proceed. The contractor and the consultant agree upon which method of valuation of variation orders should beused. The valuation of variation orders, while seen as an administrative step in theremuneration of changes effected to the contract, is in reality a rather complex matter involving a thorough understanding of contractual provisions, costing principles and an exercise of fair judgment on the part of the valuers (Harbans, 2003).

The valuation of variation orders may be in the form of:

- Rates where contracted rates are adopted where the varied works are of similarcharacter and extent and executed under similar conditions to items in thecontract bills (Wainwright & Wood, 1983; JBCC, 2005);
- Day works which consist of the payment of executed works on a basiscalculating the prime cost of works including materials, labour, plant hire andtransport plus a percentage addition as agreed between parties to the contract(Harbans, 2003);
- Quotation where contractors submit a quotation to effect the work contained ina variation order; and
- Quantum meruitis a miscellaneous method where negotiated or agreed rates orpayment are made on a reasonable sum (Harbans, 2003).

Generally the processes of variation order shown in figure 2.1

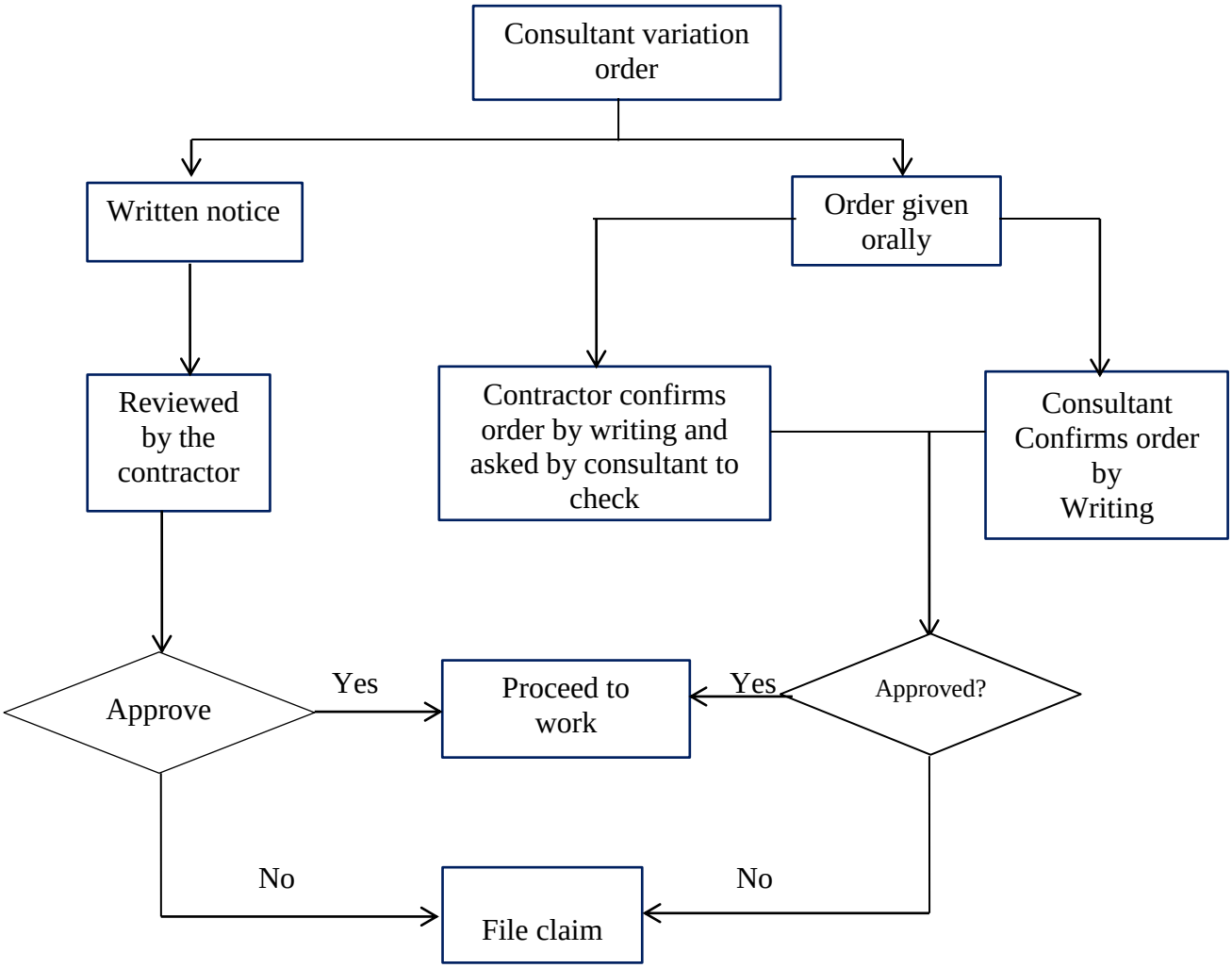

Figure 2.1 Variation order process

2.9 Chapter summary

This chapter reviewed literature on variation orders and their impacts on project performance. Variation orders can potentially occur on all construction projects. They occur due to a number of reasons that include changes in design, construction, fabrication, transportation or operability. Two types of variation orders were identified namely beneficial variation orders that lead to value improvement; and detrimental variation orders that lead to value degradation.Four origin agents for variation orders were identified. These included theclient, the consultant,

Contractorand unspecified "others". A comprehensive list of causes stemming from the four origin agents was developed. The literature suggested that the

- Change of schedule
- Change in scope
- Owner's financial problem
- Impediment prompt decision
- Obstinate nature of the owner
- Change in specification by the owner
- Change in design by the consultant
- Conflict among the contract document
- Design complexity
- Inadequate working drawing detail
- Change in specification by the consultant
- Unavailability of equipment
- Shortage of skilled man power
- Contractor's financial difficulty
- Poor work man ship
- Lack of strategic planning and
- In adequate design, werefactors influencing the occurrence of variation orders on construction projects

The occurrence of variation orders adversely impacts the performance ofconstruction projects by, for example, contributing to cost and time overruns. The frequent occurrence of variation orders can affect the overall quality of works. If not carefully administered, a variation order may give rise to disputes between parties to the contract. From the literatures a list of effects (impacts) of variation orders were identified

- Progress is affected but without any delay
- Increase in project cost
- Hiring new professionals
- Increasing in overhead expense
- Delay in payment
- Quality degradation

- Productivity degradation
- Procurement delay
- Rework and demolition
- Logistics delay
- Damage to firm's reputation
- Poor safety condition
- Poor professional relations
- Despite among professionals
- Additional payment for contractors
- Completion schedule delay

CHAPTER THREE

RESEACH METHODOLOGY

3.1 Introduction

This chapter discusses the methodology that has been used in the research. The research methodology was chosen to comply with the aim and objectives which assist finalizing this research study. This chapter included information about the study approach, sample size, data collection technique, the design of questionnaire and evaluation, final format and content of the questionnaire, and analytical methods for the data.

3.2 The Study Approach

The methods of data collection impact the analyses, the results, conclusions, values and validity of the study at the end. From the theoretical point of view, qualitative approach seeks to gain insights and understanding people's perceptions of the world. This research can be both qualitative and quantitative. It is qualitative, because the study focused to obtain the perceptions of public building construction stakeholders relative to the impact of variation orders. Case studies were conducted on specific public building projects in Addis Ababa. The case studies on the selected sites involved the observation of site documents project participants' opinion and the exploration of the physical works. The study is also quantitative, because it focused on measurements of the variables that identified from the literatures to get answers for the formulated questions. The study approach consists of combinations of qualitative and quantitative methods strengthened with the literature review. Generally the study follows the flow chart shown in figure 3.1 to achieve the object.

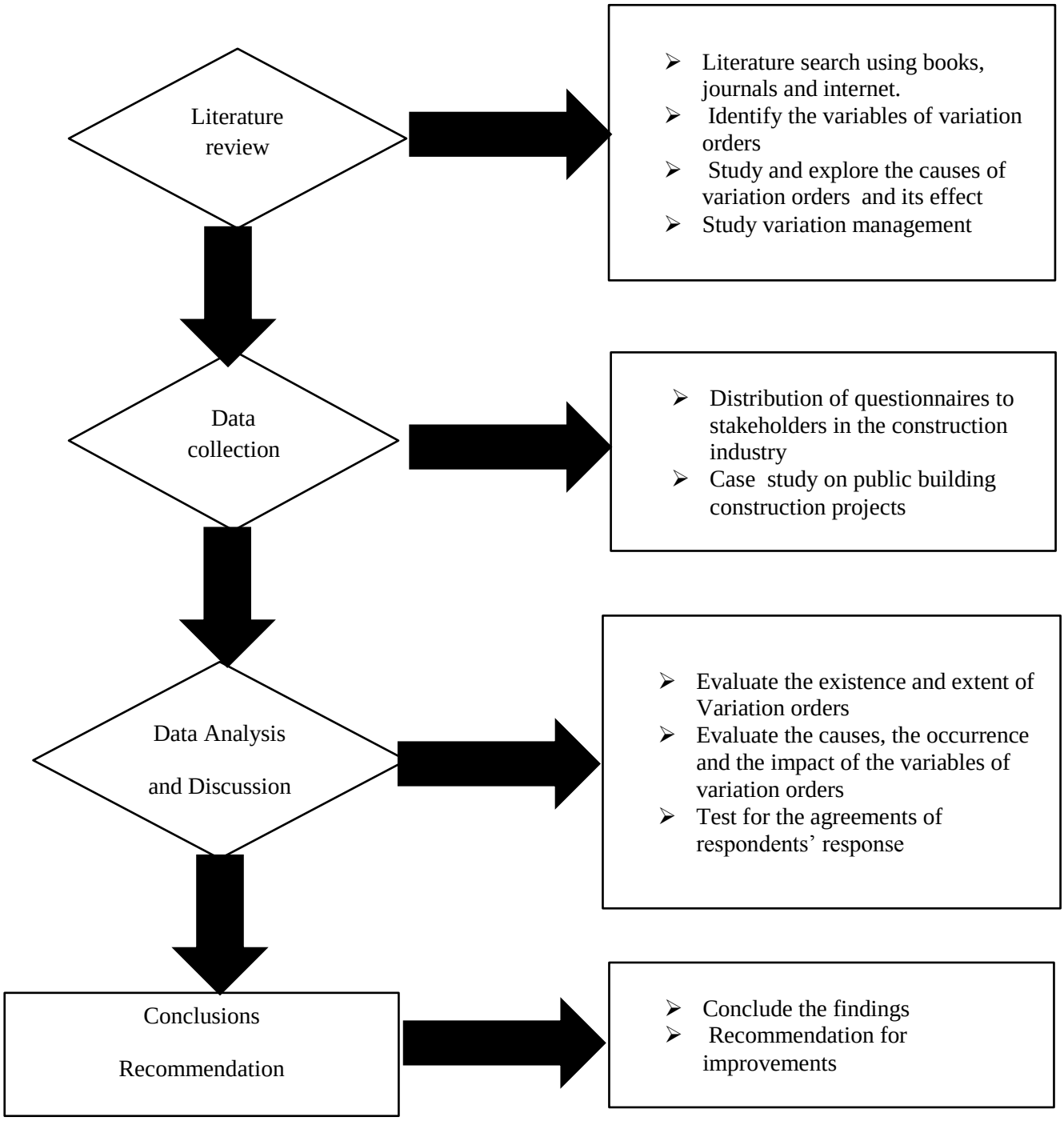

Fig. 3.1 Flow chart of research organization

3.3 Population and Sampling Techniques

The study population this research addressed was those Twenty(20)**(See Appendix B)**public building construction projects which were under construction in Addis Ababa from the commencement of work April 2012 G.C with more than 60% completed projects from different sectors were selected. The projects selected limiting their progress, work schedules and in

whichvariation orders were approved. From the Twenty(20) projects only Six (6) in which variation orders (VO) approved were selected for case study. The other populations were the stakeholders in the Addis Ababa city government public building projects namely clients (project owners), contractors and consultants especially those who work as contract administrators and project follow up engineers from contractor, consultant and client at head office level and project managers, office engineers and resident engineers at projects to which the questionnaires were sent. A total of 40 questionnaires which dealt with variation orders were distributed to the stake holders. However, only 32 questionnaires were collected.

3.4 DataCollection

According to Kumar (1999), data sources can be divided into two primary and secondary.Primary data is collected from primary sources like Observation, Interviewing and Questionnaire and Secondary data is collected from secondary sources like: government publications, earlier researches, and personal records. The primary data sources for this study include; contract document, provisional acceptance document & payment certificatessince these data's haven't been used for any other related research purpose, according to Abraham (2008) citing Kumar (1999), they are regarded as primary data for this research.The secondary data for this study were generated from construction management journals, Articles and Masters dissertations related to construction variation orders.

3.5 Method of Analysis

Both descriptive and inferential statistics are employed in the data analysis. In the analysis the "Mean Score" method is adopted to establish the relative importance of the causes of variation orders and the impacts on public building construction projects in Addis Ababa. As discussed earlier Likert's scale of five ordinal measures of agreement towards each statement (0, 1, 2, 3 and 4) is used to calculate the mean score for each factor that is used to determine the relative ranking.The mean score (MS) for each variables of variation orders is computed by using the following formula;

$$MS = \sum (f \times S)/N \quad \text{---------- [3.1]}$$

Where:

MS – Mean Score

f – Frequency of responses for each score

S – Scores given to each factor (from 0 to 4)

N – Total number of responses concerning each factor

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION

4.1. Introduction

This chapter describes the results and discussion of Case study, interview and questionnaire survey concerning causes and impacts of variation orders on public building projects in Addis Ababa from the professional's point of views. The collected data from the questionnaires were tabulated and analyzed using "Mean Score" method according to their ranking. This chapter included sights on respondents' profile and the way of implementing their work, quantitative analysis of the questionnaire, and finally the summary of the results.

4.2 Analysis of Data from the Case study

A total of twenty (20) project samples are taken for the study. From these one (1) completed and Five (5) above 60% completed a total of six(6) projects in which variation orders (VO) approved were selected for case study in order to fully understand the causes and impacts of variation orders and to determine what recommendations or strategies could be taken to minimize variation orders on public building projects. These projects were 60%and above completed and selected as a representative to the occurrences of variation orders of each of the public building projects. The list of selected projects is shown on Table **4.1**.

Table 4.1: List of selected building projects

Project code	Project Name	Contract Amount (Birr)	Contract Time (Calendar days)	Payment approved until April 2017 (Birr)	Time Extension approved Until April 2017 (days)	V.O approved until April 2017 (Birr)	Percent of V.O approved with respect to contract amount (%)	Percent of time extension approved with respect to contract Time (%)
Project 1	Children and youth theater	348,331,851.14	1095	196,807,495.89	131	30,196,041.01	8.67	11.96
Project 2	Bole Sub city Administration office	227,128,479.18	558	211,229,485.64	1207	45,250,000.00	19.92	216.31
Project 3	Lion Zoo	91,202,354.24	720	47,425,224.20	1105	32,000,000.00	35.09	153.47
Project 4	RasHailu swimming pool	58,775,839.89	365	41,398,556.53	1443	36,000,000.00	61.25	395.34

Project 5	Addis Ababa Science & Technology University dormitory(DO-CYT-T1-226)	8,383,398.46	270	15,661,111.59	550	7,277,713.13	86.81	203.70
Project 6	Holland Embassy Green Area	38,317,768.90	365	39,277,267.09	237	10,350,000.00	27.01	64.93

(Source: Addis Ababa Science & Technology University project office & Addis Ababa city governmental bureau (2017))

4.2.1 Project 1

Project1 was 72% completed project .The contract amount of this project was 348,331,851.14 Birr and the original contract time was 1095 calendar days. The project was exposed for variation due to right of way problem (demolishing of existing structures),redesign of the whole structural design for structural stability, items missed in the contract documents for civil works, design change of electrical work and change in specification of sanitary works .due to this changes a total of 30,196,041.01Birr variation order was approved and a time extension of 131 calendar days was granted which was a time overrun of 11.96% over the planned works duration. Payment for variation works was delayed because of the late approval of unit price of the variation works.

4.2.2 Project 2

Project 2 was 99.8% completed project. The contract amount of this project was 227,128,479.18 Birr and the original contract time was 558 calendar days. The project was exposed to variation due to incomplete specification of Mechanical work, additional work orders by the client interest i.e(electrical fixture works, Aluminum partition wall and septic tank). Due to these changes a total of 45,250,000.00 Birr variation order was approved with unjustified time extension of 1207 calendar days which was a time overrun of 216.31% over the schedule of the work .in addition during the construction period the variation approval process and delay of payment were the main problems.

4.2.3 Project 3

Project 3 was 90% completed project. The contract amount of Project 3 was 91,202,354.24 Birr and the original contract time was 720 calendar days. The project was exposed for variation orders due to lack of previous experience of the consultant in related Projects, because of this repeated sample of the project was done which extra costs the client, in addition tern of reference for the contract and specification of the work was prepared after the construction started with un clear specification and incomplete design. Because of these complications the project was also interrupted for one year. Due to these changes a total of 32,000,000.00 Birr variation order was approved with unjustified time extension of 1105 calendar days which was a time overrun of 153.47% over the planned works duration.

4.2.4 Project 4

Project 4 was 75% completed project. The contract amount of this project was 58,775,839.89 Birr and the original contract time was 365 calendar days. The project was exposed for variation orders due to additional work orders by the client interest, in complete specification, change in specification on some item of works ,lack of previous experience of the consultant in international swimming pool design i.e(incompatibility of the actual site condition with the design, in complete design, incompatibility of design with the specification)because of these reasons redesign of swimming pool was done and the swimming pool reinforcement bar arranged for concrete casting was demolished and reworked .Due to this changes an amount of 36,000,000.00 Birr variation order was approved and the project exposed to time extension of 1443 calendar days which was a time overrun of 395.34% over the schedule of the work.

4.2.5 Project 5

Project 5 was 100% completed project. The contract amount of this project was 8,383,398.46 Birr and the original contract time was 270 calendar days. The project was exposed for variation orders due to under estimation of initial quantity in the contract document and change of stair case type for dormitory from steel structure to reinforced concrete .Due to this changes an amount of 7,277,713.13 Birr variation order was approved and a time extension 550 calendar days was granted which was a time overrun of 203.7 %over the planned works duration. In addition due to delay on completion period of the construction the project was exposed for price escalation.

4.2.6 Project 6

Project 6 was 98% completed project. The contract amount of this project was 38,317,768.9 Birr and the original contract time was 365 calendar days. The project was exposed for variation orders due to additional works by client interest, under estimation of initial quantity in the contract document, in compatibility of the actual site condition with the design and demolishing of excising structure. Due to these changes an amount of 10,350,000.00 Birr variation order was approved and a time extension 237calendar days was granted which was a time overrun of 65% over the planned works duration.

Table 4.2: Summary of causes and impact of variation orders data from the desk study

Project	**Causes of variation order**	**Impact of variation order**
Project 1	➢ Missed item of work in the contract document ➢ Redesign of the whole structural design ➢ In sufficient time for design and preparation of contract document ➢ Design change ➢ Change in specification ➢ Right of way problem	➢ Delay on completion period of the project ➢ Increase on project cost ➢ Payment delay
Project 2	➢ In complete specification ➢ Additional work order	➢ Delay on completion period of the project ➢ Increase on project cost ➢ Long process on variation approval ➢ Delay of payment
Project 3	➢ Lack of previous experience of the consultant in related Projects	➢ Delay on completion period of the project

	➢ Repeated design change ➢ Incomplete design ➢ Design complexity and difficulty to understand	➢ Increase on project cost ➢ Difficult of contract administration ➢ Dispute among the parties ➢ Interruption of the project ➢ extra cost on the client for design & preparation of turn of reference
Project 4	➢ Lack of previous experience of the consultant in related Projects ➢ Additional work order ➢ Change in specification of some item of works ➢ In complete specification ➢ Not incorporating the required professionals at the design period. ➢ Lack of coordination	➢ Delay on completion period of the project ➢ Dispute among the parties ➢ Increase on project cost ➢ extra cost on client for redesign ➢ Difficult of contract administration
Project 5	➢ under estimation of initial quantity in the contract document ➢ change in design and specification	➢ Delay on completion period of the project ➢ Increase on project cost ➢ the project exposed for price escalation
Project 6	➢ under estimation of initial quantity in the contract document ➢ In compatibility of the actual site condition with the design (design problem) ➢ Additional work order by the client request	➢ Delay on completion period of the project ➢ Increase on project cost ➢ Delay of payment

4.2.7 Findings from the Case Study

The case study was applied to six (6) selected projects of public building construction contract documents.

4.2.7.1 Causes of Variation Orders

Fromthe case study numerous types of causes of variation orders observed in answering the first objective.The document study finding of summary of causes of variation orders from the six projects contract documents shown in **Table 4.3**

Table 4.3: Causes of variation orders from the case study

S.N	Causes of Variation Orders
1	Not incorporating the required professionals on the design
2	In sufficient time for design , preparation of specification& contract document
3	Change in design
4	Change of specification
5	Changes in owners' interests /Requirements
6	Lack of previous experience of the consultant in related Projects
7	In compatibility of the actual site condition with the design
8	under estimation of initial quantity in the contract document
9	Right of way problem
10	Design complexity and difficulty to understand
11	Incomplete design
12	Lack of coordination

4.2.7.2 Impact of Variation Orders

From the case study findings, the followings are summary of the impacts of variation orders identified in answering the second objective.The document study finding of summary of impacts of variation orders from the six (6) projects contract documents shown in **Table 4.4**.

Table 4.4: Impacts of variation from the desk study

S.N	Impacts of Variation Orders
1	Delay on completion period
2	Increase on project cost
3	Dispute among the parties

4	Payment delay
5	Price escalation due to delay on completion period
6	Difficulty on managing the contract
7	Difficult of contract administration
8	Interruption of the project
9	Extra cost on the client

4.3 Analysis of Data from the Questionnaires

4.3.1 Questionnaire Response Rate

Detailed questionnaires were designed and distributed for the assessment of impacts of variation orders on public building construction projects in Addis Ababa, for this purpose the questionnaires were distributed to major stakeholders in the construction industry; these are Contractors, Consultants and Clients (project owners). To make the analysis more comprehensive a total of 40 questionnaires were distributed to consultants, contractors and clients (project owners) out of them 32 questionnaires were filled and returned. Table 4.1 below shows the number of questionnaires distributed to clients, consultants and contractors and the number of questionnaires returned from these stakeholders including their percentage response rate.

Table 4.5: Summary of questionnaires distributedand returned; and response rate

No	Respondent	Questionnaire Distributed	Questionnaire Returned	Response Rate (%)
1	Client	6	4	66.67
2	Consultant	14	10	71.43
3	Contractor	20	18	90.00
Total		40	32	80.00

4.3.2 Respondents' Profile

The target respondents of the questionnaire survey were engineers from different positions in the construction industry in Addis Ababa. Among the four responses received from clients, One(25%) of them wasproject coordinator while three (75%) were project follow-up engineers.Among the 10 responses received from consultants, seven (70%) of them were resident

engineers and three (30%) were contract administrators. And among the eighteen responses received from contractors, five (27.8%) of them were contract administrators, five (27.8%) of them were project managers, ten (55.6%) office engineers.

4.3.3 Respondents' Experience

The respondents have different levels of work experience in building projects25 % (8) of the respondents firm have experience between 1to 5 years in construction works and 43.8% (14) of the respondents experience between 5 to 10years, 31.3 % (10) of respondents have experience 10 years and above.

Table 4.6 Respondents' Experience

Experience	Client	Consultant	Contractor	Total
1 to 5 years	3	2	3	8
5 to 10 years	0	7	7	14
10 years and above	1	1	8	10

4.3.4 Findings from the Questionnaires

In the questionnaire, the respondents were asked to rate the degree of contribution of the variables drawn from the literature review. Furthermore, the respondents were also asked to add other variables or factors that contributed to the causes and impacts of variation orders as well as recommendations that they perceived as being necessary. Forty seven (45) causes of variation orders,eighteen (18) impacts of variation orders and fifteen (15) strategies to minimize variation orders on building projects were used in questionnaire survey. The analysis was made from the response of the returned thirty two (32) questioners. A ranking system using the "Mean score (MS)"method was calculated to find the most significant factor for each section.

4.3.4.1 Cause of variation orders on public building projects

Table 4.7 depicts the respondents' rating of the causes of variation orders on public building projects. It is notable that all causes in the category have $1 \geq MS \leq 5.00$, which indicates that respondents identify the causes as falling between minor causes and major causes. As indicatedon Table 4.7 The most raked causes of variation orders by respondents wereincomplete design at the time of tenderwith a mean value (MS=4.9).Change in specifications (MS=4.7) and differing site conditions(MS= 4) were the second and the third ranked causes. Lack of coordinationand insufficient time for preparation of contract documents & design were the fourth ranked

causes of variation orders with the same mean value of (MS=3.6).Obstinate nature of one or more of the parties to the contract(MS=1.35) and socio-cultural factors(MS=1.33)were the least ranked causes of variation orders.

Table 4.7: Causes of variation orders

S.N	Causes of variation orders	Mean	Ranking
1	Incomplete design at the time of tender	4.9	1
2	Change in specifications	4.7	2
3	Differing site conditions	4	3
4	Lack of coordination	3.6	4
5	Insufficient time for preparation of contract documents & design	3.6	4
6	Change in design	3.4	6
7	Errors and omissions in design	3.12	7
8	Inadequate design team experience	3.01	8
9	Improper briefing by client	2.95	9
10	Unfamiliarity with or unawareness of local conditions	2.9	10
11	Owner instructs modification to	2.87	11
12	Under estimation of initial quantity in the contract document	2.8	12
13	Impediment in prompt decision making process	2.79	13
14	Lack of involvement in design of one or more parties to the contract	2.79	13
15	Lack of knowledge of available materials and equipment	2.7	15
16	Design complexity	2.69	16

17	Inadequate scope of work for one or more parties to the contract	2.67	17
18	Replacement of materials or procedures	2.66	18
19	Lack of communication	2.65	19
20	Conflicts between contract documents	2.55	20
21	Financial problems	2.5	21
22	Defective workmanship	2.5	21
23	Design discrepancies	2.43	23
24	Long lead procurement	2.37	24
25	Poor procurement process	2.32	25
26	Ambiguous design details	2.25	26
27	Lack of judgment and experience	2.25	26
28	Lack of a specialized construction management	2.25	26
29	Non-compliant design with owner's requirement	2.1	28
30	Weather conditions	2.08	30
31	Unforeseen problems	1.99	31
32	Lack of required data	1.99	31
33	Unavailability of skills	1.97	33
34	Change of plans or scope	1.9	34
35	Inadequate project objectives	1.87	35
36	Health and safety considerations	1.87	35
37	Change in government regulations	1.82	37

38	Inadequate shop drawing details	1.82	37
39	Non-compliant design with government regulations	1.75	39
40	Change of schedule	1.63	40
41	Lack of strategic planning	1.59	41
42	Technology change	1.52	42
43	Unavailability of equipment	1.44	43
44	Obstinate nature of one or more of the parties to the contract	1.35	44
45	Socio-cultural factors	1.33	45

4.3.4.2 Impacts of variation orders on public building projects

Table 4.8 depicts the respondents' rating of the impacts of variation orders on public building projects. It is notable that all impacts in the category have $1 \geq MS \leq 5.00$, which indicates that respondents identify the impacts as falling between no impact and very high impact.As indicated in Table**: 4.8** below, the most ranked impacts of variation orders from the responses of respondents were completion schedule delay with a mean value of (MS=4.85) followedby increase in project cost (MS=4.7). Procurement delay and delay in payment were the third impacts with the same mean value of (MS=4.5). Quality degradation (MS=2.2)and poor safety condition (MS=1.9) were the least ranked impact of variation orders.

Table 4.8: Impacts of variation orders

S.N	**Impacts of variation orders**	Mean	Rank
1	Completion schedule delay	4.85	1
2	Increase in project cost	4.7	2
3	Procurement delay	4.5	3
4	Delay in payment	4.5	3
5	Progress is affected but without any delay	4.3	5
6	Additional payments for contractor	4.3	5
7	Additional specialist equipment/personnel	4.21	7

8	Productivity degradation	4.21	7
9	Increase in overhead expenses	4.21	7
10	Logistics delays	3.6	10
11	Rework and demolition	3.45	11
12	Disputes among professionals	3.2	12
13	Damage to firm's reputation	2.95	13
14	Professional reputation of one or more parties adversely affected	2.86	14
15	Complaints of one or more of the parties to the contact	2.7	15
16	Poor professional relations	2.45	16
17	Quality degradation	2.2	17
18	Poor safety conditions	1.9	18

4.3.4.3 Recommended Strategies to Minimize Variation Orders

Table 4.9 depicts the respondents' rating of the recommended strategies to minimize variation orders on public building projects. It is notable that all recommendations to minimize variation orders in the category have $1 \geq MS \leq 5.00$, which indicates that respondents identify the recommendationsas falling between un importantand very high important.According to Table**: 4.9**, the most ranked recommended strategy to minimize variation orders was complete the drawing at tender stage with the mean value of (MS=4.6).All involved parties should plan adequately before works start on site and clients should provide a clear brief of the scope of workswere the second ranked strategic recommendations with equal mean value of (MS=4.3).All parties should forecast unforeseen situations (MS=2.22) and have the land application or land purchase completed before awarding contracts (MS=2.1) were the least ranked recommended strategy to minimize variation orders.

Table 4.9: Recommended strategies to minimize variation orders

S.N	**Recommended strategies to minimize variation orders**	**Mean**	**Rank**
1	Complete the drawings at tender stage	4.6	1
2	All involved parties should plan adequately before works start on site	4.3	2

3	Clients should provide a clear brief of the scope of works	4.3	2
4	The consultant should co-ordinate closely at design stage	4.01	4
5	Spend adequate time on pre-tender planning phase	3.95	5
6	Consultants should ensure that the design/specifications fall within the approved budget	3.95	5
7	The consultant should produce a concluding design and contract documents	3.95	5
8	Carry out detail site investigation including detail soil investigations and consider it during tendering stage	3.51	8
9	Get accurate information and research with regard to procurement procedure, material and plant	2.89	9
10	Supervise the works with an experienced and dedicated supervisor	2.75	10
11	Place experienced and knowledgeable executives in the engineering and design department	2.75	10
12	Once the tender is awarded, make no changes to the specifications	2.41	12
13	Enhance communication between all parties	2.32	13
14	All parties should forecast unforeseen situations	2.22	14
15	Have the land application or land purchase completed before awarding contracts	2.1	15

4.4 Discussion of Findings

This section is a recapitulative discussion of the study findings from the case study and the questionnaires. The cause of variation orders, impact of variation orders and recommendations to minimize variation orders discussed here.

4.4.1 Causes of variation orders in public building projects

From the case study and the questioner survey found that the most common causes of variation orders on public building projects were incomplete design at the time of tender, change in

specifications and under estimation of initial quantity in the contract document.As shown in table **4.7** the first major cause of variation orders was in complete design at the time of tender. Because of clients sought to minimize project delivery periods; they shortened the pre-tender period and expected the construction work to start on site as early as possible, it often goes out with designs which are subject to more revisions, leading to further variation orders. This type of practice has shown in more ways than one that the end results of incomplete designs often have variation orders .The incomplete designs often open a window for the client to increase the scope of the project further, thus resulting in increase in project cost and delay in completion period of the project .Whereas, if the designs were completed and the client involved in the process; then the scope could have been finalized without expecting immense changes later.

The second major cause of variation order was change in specifications. In a design stage, it could be a failure to change the specification due to change of mind of the client or the consultant which results in variation orders. Consequently change in specifications can be the major cause. As reviewed in the literature part of this research Ruben (2008) listed that change in specifications among the major causes.

The third major cause of variation order was differing site conditions. Ground conditions can be assessed by the use of trial pits and borehole sampling on site. However, the actual site conditions forthe fullextent of a project are not usually determined until excavation is completed. It is sometimes possible that those difficult conditions are over looked by the initial review or conditions have changed due to adverse weather conditions or changes in sub soil conditions. Unexpected sub surface conditions can, at time, require fundamental redesign of projects at great expense which leads to a greater variation orders.

4.4.2 Impacts of variation orders

The case study and the questioner survey results shows that the most common impacts of variation orders on public building projects were completion schedule delay, increase in project cost , delay in payment and procurement delay. As ranked in table **4.8** previously the first impact of variation orders was completion schedule delay followed by increase in project cost, delay in payment and procurement delay. The firstvictim from completion schedule delay and increase in project cost is the project end user that is the people of the city. Although the degree of impacts completion schedule delayand increase in project cost varies on the stakeholders in the

construction industry, all the parties involved are affected. Increase in project cost does notaffect only those parties that are involved directly in the construction of a project, but its impactpass to the construction industry as a whole and consequently to the national economy of the country. If there is excessive increase in project cost then it requires additional budget, this in turn affect the scarce financial resources of the country, which lead to further budget short fall for construction projects. This prevents the planned increase in property and service production from taking place and this phenomenon in turn affects, in a negative way, the rate of national growth. Increase in project costwill also be a source of dispute among stakeholders and it will lead to adversarial relationship among project participants. Client will lose confidence on consultant and on professionals in general. To the industry as a whole, project cost increase could bring about a drop in construction activities, bad reputation, and inability to secure project finance easily form public authorities in the future.The third impact of variation orders on public building projects were delay in payment. Delays in the payments forservices by theproject owners or clients can leadto significant problems.If the costs of a project have increasedsignificantly beyond the original estimate, then work on the project may have to be stopped or be delayed until additional funds can be found.Delayson the on payments may sometimes provoke the contractor to claim for interest rates. If the payment by a project owner is slow, the contractor may begin to commit fewer resources to the project, and may even cease work if cash flow becomes a problem. Procurement delay also ranked as the third impact of variation order.This finding is supported in the work Arain and Low (2005), variations that require new materials and specialized equipment are the cause for frequent procurement delays. Procurement delays were common effects of variations related to new resources for construction projects (Hester et al., 1991).

4.4.3 Recommended Strategies to Minimize Variation Orders

According to the findings from the interview and questioner surveys, the suggested recommendations by the respondents werecomplete the drawings at tender stage, carry out detail site investigation including detail soil investigations and consider it during tendering stage and spend adequate time on pre-tender planning phase.From the suggested strategies most rankedwas that of the complete the drawings at tender stage. The impact of complete the drawings at tender stage are that it regulates the unnecessary additions that the client could exploit, due to incomplete drawings. Finalization of the drawing gives the project team a framework for what to expect from the project. The monitoring of the project's progress may be easily handled since

one very important aspect has been finalized. Following on this all involved parties should plan adequately before works start on site. Projects that are better prepared and adequately planned often are completed with minimal disruptions or unnecessary expenses. The next one wasclients should provide a clear brief of the scope of works. This ensures that the designs include all the needs of the client, leaving a limited opportunity for changes at a later stage.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

5.1.1 Causes of variation orders on public building projects in Addis Ababa

As presented in chapter one the first objective of this study was to identify the main causes of construction variation orders on public building construction projects in Addis Ababa. From the six projects case study set that the most frequent cause of variation orders was design change followed by additional work order by the client interestand change in specification.

According respondents of the questioners' rated incomplete design at the time of tender, change in specifications and differing site conditions were the most frequent cause of variation orders.

From the findings of the case study and questionnaire, design change , additional work order by the client interest, change in specification, incomplete design at the time of tender, and differing site conditions were the major causes of variation orders

5.1.2 Impact of variation orders on public building projects in Addis Ababa

The second objective of this study was to assess the impact of construction variation orders on public building construction projects in Addis Ababa. From the case study the data found that delay in completion period, increase in project cost and payment delay were the most frequent impacts of variation orders.

As the questioner respondents ranked from the 18 impacts of variation orders, completion schedule delay, increase in project cost,delay in payment and procurement delay were the top three most frequent impacts of variation orders.

From the findings of the case study and questionnaire completion schedule delay,increase in project cost and delay in payment were the major impacts of variation orders

5.1.3 Recommended strategies to minimize variation orders

The thirdobjective of this study was to forward recommendations to effectively control and manages construction variation orders.

From the response of questioner surveys the top three frequent ranked recommended strategies to minimize variation orders were complete the drawings at tender stage,all involved parties should

plan adequately before works start on site andclients should provide a clear brief of the scope of works.

5.2 Recommendations

Based on the findings of the research, the following recommendations are expected fromkey role players in construction projects.

5.2.1 Expected From Clients/Project Owners

Clients are one of the most important parties who invest their money for realization of construction project, and they are the key role players starting from conception through construction up to operation of the project. The following recommendations are expected from clients.

1. Clients should allow sufficient time to prepare project briefs and other feasibility studies. Allow sufficient time for proper feasibility studies, planning, design, information documentation and tender submission. This helps to avoid errors and omissions that consequentially help in avoiding or minimizing variation order.
2. Ensure comprehensive articulation and communication of owner and end-user needs and requirements during briefing sessions; client goals should be sufficiently accurate and realistic.
3. Fulfill contractual obligations, especially as regards to payment of contractor'sworks duly executed and possessionof construction site. Clients should ensure that adequate funds are available beforeprojects are started, so that contractors can be paid in accordance with the contractagreement
4. Hire a consultant who specializes in the nature of thework.
5. Develop criteria for the selection of contractoraccording to the nature of the project and to have a good reputation and greatexperience
6. Include everything they need in the contract fromthe beginning and avoid any requirements after implementation of works anddevelop a clear vision for projects.

5.2.2 Expected from Consultants

The consultant is one of the key role players in construction projects that translates theclients' needs and ideas in to plans and drawings and supervises the translation of these plans and

drawings into visible physical structures. The following recommendations are expected from consultants.

1. Continuous coordination and direct communication, which will eliminate designdiscrepancies and errors as well as omissions in design and also provide anopportunity for professionals to review the contract documents thoroughly. This would help in eliminating variations due to discrepancy incontract documents.
2. Provide comprehensive information required for easier interpretation of thedrawings and setting out of the works. Specifications should also be standardizedas much as possible for ease of understanding by project participants; ensureadequate and realistic specifications of materials and methods are stated in thecontract documents.
3. Detailed and comprehensive site investigation should be done at the design phaseto avoid variations and late changes during the construction phase
4. As much as possible avoid complex designs, while trying to achieve aesthetic appeal, consider seriously the issue of build ability in the design
5. After completion of designs and plans,cross-check designs and details to eliminate errors.
6. Search and explore the equipment andmaterials that are available in the country and how to deal with it.

5.2.3 Expected From Contractors

Contractors are one of the stakeholders who participate directly on the constructionprojects; accordingly the following recommendations are expected from contractors.

1. Hire qualified workers, engineers, and projectmanager with good experience to avoid any problems at work.
2. Keep safety first in the site for all people andthe project. In addition, give training for workers and should set asafety officer to be always on site.
3. Requests for information should be addressed in a timely and adequate manner.
4. Get accurate information and research with regard to procurement procedure,material and plan.

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APPENDEX

APPENDEX A

QUESTIONNAIRE FOR RESEARCH

Introduction

This questionnaire is prepared to obtain information from key informants with semi- structured questions. The information is required for the academic research entitled "Impacts of variation orders on public building projects in Addis Ababa", which is being conducted as partial fulfillment of Mengin construction technology and management. The main objectives of the research is to identify the main causes of construction variation orders in public building construction projects in Addis Ababa,to assess the impact of construction variation orders on public building construction projects in Addis Ababa & to forward recommendations based on the findings to effectively control and manage construction variationorders. The questionnaire consists of four sections. Section A general organization information. Section B contains causes of variation OrdersSection C contains impacts of variation orders andSection DcontainsRecommendations to minimize variation orders. At the end there is a space that left for general comments regarding the research topic.Your response, in this regard, is highly valuable and contributory to the outcome of the research. All feedback will be kept strictly confidential, and utilized for this academic research only.

Thank you,

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Addis Ababa

SECTION A: GENERAL ORGANIZATION INFORMATION

1. Name of organization: ----------

2. State respondent organization/company type.

Client ☐ Contractor ☐ Consultant ☐

3. Respondents designation:

Owner of organization ☐ Project manager ☐ Office engineer ☐

site engineer ☐ Resident engineer ☐ Site supervisor ☐

Other_____

4. Relevant work experience

1 to 5 years ☐ 5 to 10 years ☐ above 10 years ☐

SECTION B: CAUSES OF VARIATION ORDERS IN PUBLIC BUILDIN CONSTRUCTION PROJECTS IN ADDIS ABABA

Please indicate your level of agreement with the following questions on a scale 1 to 5.

Indicator: 1 = Never

2 = Seldom

3 = Sometimes

4 = Often

5 = Always

From your point of view (and regardless of your experience) select the degree ofinfluence and the degree of occurrence that lead to the presence of variation orders on public building projects.

S.N	Causes of variation orders	Never				Always
		1	2	3	4	5
1	Change of plans or scope					
2	Change of schedule					
3	Change in specifications					
4	Change in design					
5	Errors and omissions in design					
6	Incomplete design					
7	Non-compliant design with government regulations					
8	Impediment in prompt decision making process					
9	Unforeseen problems					
10	Replacement of materials or procedures					
11	Inadequate shop drawing details					
12	Lack of judgment and experience					
13	Financial problems					
14	Inadequate scope of work for one or more parties to the contract					
15	Design complexity					
16	Lack of communication					
17	Defective workmanship					
18	Design discrepancies					

19	Inadequate project objectives					
20	Long lead procurement					
21	Lack of coordination					
22	Ambiguous design details					
23	Unavailability of skills					
24	Weather conditions					
25	Lack of strategic planning					
26	Lack of knowledge of available materials and equipment					
27	Lack of involvement in design of one or more parties to the contract					
28	Non-compliant design with owner's requirement					
29	Health and safety considerations					
30	Lack of a specialized construction management					
31	Obstinate nature of one or more of the parties to the contract					
32	Differing site conditions					
33	Poor procurement process					
34	Conflicts between contract documents					
35	Lack of required data					
36	Unavailability of equipment					
37	Unfamiliarity with or unawareness of local conditions					
38	Socio-cultural factors					
39	Change in government regulations					
40	Technology change					
41	Insufficient time for preparation of contract documents& design					
42	Improper briefing by client					
43	Inadequate design team experience					
44	Owner instructs modification to					

	Design					
45	Under estimation of initial quantity in the contract document					

If any other causes of variation orders, please specify_____
_____
_____
_____
_____
_____
_____

SECTION C: IMPACTS OF VARIATION ORDERS IN PUBLIC BUILDIN CONSTRUCTION PROJECTS IN ADDIS ABABA

Please indicate your level of agreement with the following questions on a scale 1 to 5.

Indicator: 1 = No impact

2 = Low impact

3 = Medium impact

4 = High impact

5 = Very high impact

S.N	**Impacts of variation orders**	**No impact**				**very high impact**
		1	**2**	**3**	**4**	**5**
1	Increase in project cost					
2	Progress is affected but without any delay					
3	Increase in overhead expenses					
4	Delay in payment					
5	Quality degradation					
6	Productivity degradation					
7	Procurement delay					
8	Rework and demolition					
9	Logistics delays					
10	Additional specialist equipment/personnel					
11	Poor safety conditions					

12	Poor professional relations					
13	Additional payments for contractor					
14	Disputes among professionals					
15	Completion schedule delay					
16	Complaints of one or more of the parties to the contact					
17	Professional reputation of one or more parties adversely affected					
18	Damage to firm's reputation					

If any other impact of variation orders, please specify_____
_____
_____
_____
_____
_____

SECTION D: RECOMMENDATIONS TO MINIMIZE VARIATION ORDERSIN PUBLIC BUILDIN CONSTRUCTION PROJECTS IN ADDIS ABABA

Please indicate your level of agreement with the following questions on a scale 1 to 5.

Indicator: 1 = Unimportant

2 = Less important

3 = Important

4 = Very important

5 = Very high important

S.N	**Recommendations to minimize variation orders**	**Un important**				**very high important**
		1	**2**	**3**	**4**	**5**

1	All involved parties should plan adequately before works start on site					
2	The consultant should produce a concluding design and contract documents					
3	Complete the drawings at tender stage					
4	Spend adequate time on pre-tender planning phase					
5	Clients should provide a clear brief of the scope of works					
6	All parties should forecast unforeseen situations					
7	The consultant should co-ordinate closely at design stage					
8	Enhance communication between all parties					
9	Supervise the works with an experienced and dedicated supervisor					
10	Consultants should ensure that the design/specifications fall within the approved budget					
11	Get accurate information and research with regard to procurement procedure, material and plant					
12	Carry out detail site investigation including detail soil investigations and consider it during tendering stage					
13	Have the land application or land purchase completed before awarding contracts					
14	Once the tender is awarded, make no changes to the specifications					
15	Place experienced and knowledgeable executives in the engineering and design department					

If you have any other recommendations , please specify_____
_____
_____
_____
_____
_____

APPENDIX B

LIST OF PUBLIC BUILDING PROJECTS FOR THE STUDY

(Source Addis Ababa Science & Technology University project office & Addis Ababa city governmental bureau (2017))

S.N	Projects	Building Height	Contract Amount (Birr)	Original contract time (Days)	Remarks
1	Bole sub city administration office	G+11	227,128,479.18	558	*Selected for case study*
2	AkakiKality sub city administration office	G+11	229,013,805.29	558	
3	Gullele sub city administration office	G+11	202,757,841.73	558	
4	Addis ketema sub city administration office	G+11	228,159,431.49	558	
5	KolfeKeraniyo sub city administration office	1B+G+11	250,476,941.4	730	
6	Kirkos sub city administration office	2B+G+11	297,215,448.61	730	
7	Arada sub city administration office	1B+G+11	290,081,891.8	730	
8	EthioKuba Green Area	Green Area	9,436,556.71	120	
9	Holland Embassy Green Area	G+1+green area	38,317,768.9	365	*Selected for case study*
10	Children & youth theater	1B+ G+11	348,331,851.14	1095	*Selected for case study*
11	Laboratory building	G+3	13,482,080.45	180	
12	Lions zoo	G+0	91,202,354.24	720	*Selected for case study*
13	Bole firefighting building	G+2	91,820,035.4	365	
14	Yeka sub city police commotion building	G+4	60,142,451.69	530	
15	Addis ketema sub city police commotion building	G+4	63,966,758.79	530	

16	RasHailu swimming pool & related works	G+1+ Swimming pool	58,775,839.8	365	*Selected for case study*
17	TeferiMekonnen TVTE college	G+4	11,084,605.26	180	
18	Winget Hotel and truism building	G+4	12,715,661.97	365	
19	Kotebe teaching college	G+8	66,229,291.63	730	
20	Addis Ababa Science & Technology Universitydormitory(DO-CYT-T1-226)	G+4	8,383,398.46	270	*Selected for case study*